Diet of the Bowfin in Central Florida

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Study of the diet of bowfin (*Amia calva*) in central Florida was undertaken in hopes that it would add to the scarce knowledge of the local food habits of the species, and give an indication of its role in managing fish populations. The study was conducted while I was employed by the Florida Game and Fresh Water Fish Commission as part of the federal aid project F-17-R according to the Dingell-Johnson Act. I am indebted to Roger A. Martz and Rudolph H. Howell for assistance in capturing the fish, and to Dr. John C. Briggs for his help in preparing the manuscript.

Methods

Specimens were procured by electric shocking, using a 220-volt A.C. generator, during the first three months of 1965 between the hours of 8:00 A.M. and 5:00 P.M. Only the fish along the littoral zone of the lake to a depth of about eight feet were captured. No attempt was made to shock fish in deeper water. A shocked fish could be scooped out of the water using a dip net. Individual fish were given a number, and records were kept of length, weight, and sex in addition to the exact locality of the capture, the date, and the time of day. The whole digestive tract was then cut out and immersed in 10 per cent formalin solution.

Very near the conclusion of the study it was found that merely placing the eviscerated digestive tract in 10 per cent formalin was inadequate. It was found that tape worms in the stomach were able to live up to five hours after the digestive tract was immersed. There may possibly be some food deterioration after the stomach is immersed in formalin. In future studies it would be advisable to inject the stomachs with formalin before immersion.

In the laboratory, the stomach was separated from the intestine at the pyloric constriction. The volume of the stomach contents was measured by water displacement. Individual food items were separated, identified, and counted. The volume of each food type was determined, as well as its frequency of occurrence.

To examine the diet in relation to management, fish found in the stomach contents from Lake Griffin and Lake Harris and Helena Run were categorized as rough fish or game fish.

STUDY AREAS

In this investigation, no attempt was made to determine the availability of food types from each location. However, observations while collecting yielded the following information which might help to explain diet dissimilarities in the different locations.

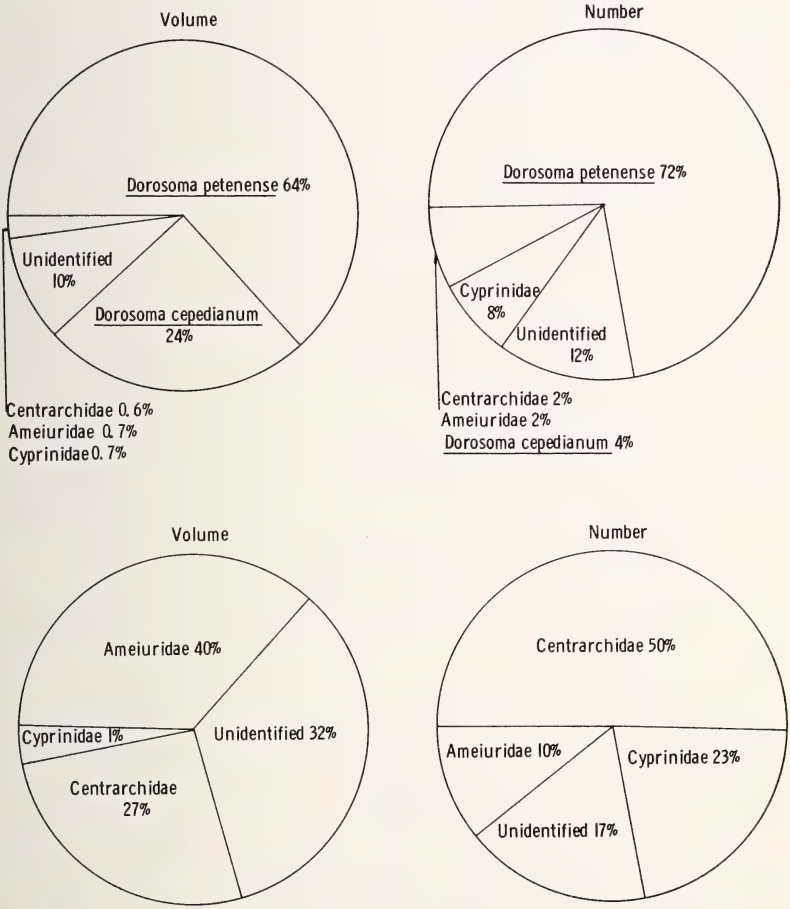

Fig. 1. Number and volume of fish from stomachs of bowfin (*Amia calva*). Upper figures are based on data from Lake Griffin, lower figures from Lake Harris and Helena Run.

Helena Run, partly a spring run fed by Bugg Spring, is located in Lake County and drains Lake Denim into Lake Harris. A swamp

borders the collecting area on both sides of the run. There are many dead-end canals extending perpendicular to the run. Many bowfin were collected in these canals, but the majority were collected in the main part of the run.

Lake Griffin is a 8,800 acre lake in Lake County drained by the Oklawaha River at the northern end. The northern third of the lake is well covered with *Nuphar*. The main collecting area was at the southwest shore. Most of the bowfin were collected in canals and along the shore in the lily pads and maiden cane. Lake Griffin is the most fertile of the collecting areas, its water very dense with phytoplankton. This fertility is partly caused by drainage from the Leesburg Sewage Treatment Plant and the Minute Maid Company Citrus Processing Plant. Twin Palms is a fish camp midway up the western shore of Lake Griffin.

Little Lake Harris is actually the southern end of Lake Harris situated between Howey-In-The-Hills and Astatula. The collecting areas were in the narrow coves and canals near Astatula. Many snakes were observed sunning on the *Nuphar* and *Eichornia* growing along the water's edge.

Lake Harris is a 17,000 acre lake south of Leesburg. It is less fertile than Lake Griffin but still has an abundant shad population. The bowfin from this location were collected along the shore to the north and south end of the mouth of Helena Run. This is primarily an area of emergent grass and cypress trees.

Venetian Gardens is a pleasure area located on Lake Harris. The bowfin from this area were collected in the deep clear canals lacing the area.

The area entitled "boat docking area" was also located on Lake Harris very near Venetian Gardens. It is a small deep cove well grown with subsurface algae appearing to be *Spirogyra*. A good population of adult bass was evident.

The St. Johns River location was not in the Leesburg area. The collecting area was out from Crow's Bluff along the shoreline of Norris Dead River among numerous *Nuphar*. This water had a higher salinity than any other area examined. In some cases the shocker could not be used because of the high salinity.

Lake Dora is a very fertile lake located in Lake County south of Tavares. The fish from this area were collected along the southwest shore in the maiden cane.

Lake Eustis is a 7,400 acre lake in Lake County located at Eustis. The bowfin collected were shocked from the shore area among the maiden cane.

RESULTS

During the course of this research, 131 bowfin were collected, 18 of which had empty stomachs. Upon examination, the full stomachs demonstrated a wide variety of food items. Some of these will be described to help clarify the data.

A red rubber fishing worm was found in a bowfin from Helena Run. Since it was not nutritious, it was not entered in the data.

Two instances of bird remains were discovered in two different stomachs, one from Little Lake Harris and one from Lake Griffin. The first was a black bird found coiled up in the spiral valve of the intestine, with only 12 feathers remaining in the stomach. The other was a coot's leg (*Fulica americana*). It is possible that the black bird was eaten alive, and that the leg was torn from a live coot, but this is doubtful. The coot's leg was in the stomach with distal end extending out of the lower esophageal region. If the coot had been alive the leg's position in the stomach should have been reversed. Of course, the bowfin might have dropped the leg and then reversed its position, but in my opinion both should be considered carrion.

Another item which could also be considered carrion was found in two bowfin from the Venetian Gardens location. This was some type of previously cooked meat, tentatively identified as a pork chop.

It should be noted that there is a high volume of detritus from Helena Run. This is because one of the bowfin contained 10 ml of mud and detritus. The same stomach also contained the remains of what seemed to be either a mud siren or eel. Perhaps the mudfish devoured the mud and detritus while in pursuit of the food item.

In several instances, vertebrae were found that could not be identified. They may have been small snakes, salamanders, or lizards. In the data they are designated as unidentified vertebrates.

It should also be noted that amphipods, and snails are included. Those found were very small and, like detritus, are probably accidental food items.

The detailed data giving the numbers, volumes, and frequencies of food items from each location are given in the following paragraphs.

The stomach contents of 26 bowfin from Helena Run contained: 25 fish with a volume of 123.8 ml and a frequency of occurrence of 14, 30 crayfish (82.3 ml, 15), 13 prawns (1.2 ml, 5), 30 insects (3.76 ml, 13), 10.77 ml of detritus with a frequency of 5, 2 amphipods found in one stomach, 1 snail (0.05 ml), 2 unidentified vertebrates (0.4 ml, 2), 4 unidentified items (4.3 ml, 2), 1 snake (175 ml), and 1 mud siren or eel with a volume of 50 ml.

Twenty-three bowfin from Lake Griffin contained: 51 fish (288 ml, 19), 22 crayfish (32.14 ml, 12), 286 prawns (16.02 ml, 19), 10 insects (1.42 ml, 7), 0.81 ml of detritus with a frequency of 10, 10 amphipods (0.04 ml, 6), 3 snails (0.05 ml, 4), 1 salamander (1.8 ml, 1), 1 frog (1.9 ml), and the leg of a coot found in one stomach for a volume of 18 ml.

The 18 bowfin collected from Little Lake Harris were found to contain: 10 fish (48.98 ml, 8), 24 crayfish (36.15 ml, 15), 12 prawns (0.5 ml, 5), 7 insects (1.1 ml, 5), 0.04 ml of detritus from 3 stomachs, 1 amphipod, 2 snails (0.01 ml, 1), 4 unidentified items (1 ml, 3), 2 snakes (123 ml, 2), 1 salamander (0.4 ml), 1 frog (1.9 ml), and the remains of a black bird.

Twelve stomachs from Lake Harris contained: 11 fish (206.4 ml, 8), 11 crayfish (16.73 ml, 9), 9 prawns (1.28 ml, 4), 9 insects (1.38 ml, 4), 4 unidentified vertebrates (4.57 ml, 4), 1 snake (54 ml), and 1 salamander with a volume of 0.6 ml.

The ten stomachs from Lake Dora contained: 9 fish (132.5 ml, 9), 1 prawn, and 1 mud siren or eel (2.5 ml).

Nine stomachs from the St. Johns River contained: 2 fish (230 ml, 2), 3 crayfish (9 ml, 1), 7 prawns (0.42 ml, 2), 2.6 ml of detritus from 2 stomachs, 1 amphipod (0.02 ml), 1 snake (50 ml), and 2 fiddler crabs (0.9 ml, 2).

From Venetian Gardens, the five bowfin collected were found to contain: 2 fish (27 ml, 3), 2 crayfish (10.6 ml, 2), 0.8 ml of detritus from one stomach, and cooked meat remains found in two stomachs for a volume of 47.2 ml.

Five stomachs from Lake Eustis contained: 5 fish (2.95 ml, 3), 5 crayfish (5.4 ml, 3), 82 prawns (12.4 ml, 5), 13 insects (1.6 ml, 2), 5 amphipods found in two stomachs, and 2 snails (0.02 ml, 1).

Four stomachs from Twin Palms contained: 5 fish (2.43 ml, 4), 3 crayfish (12.2 ml, 2), 273 prawns (22 ml, 4), 1.5 ml of detritus from two stomachs, 10 amphipods (0.03 ml, 2), 1 snail (0.02 ml), and 1 unidentified item with a volume of 0.8 ml.

Two stomachs from the "boat docking area" contained: 1 fish (2 ml), 2 crayfish (1.7 ml, 2), and 0.2 ml of detritus from both stomachs.

The stomach from Lake Yale contained: 1 prawn, and 1 unidentified vertebrate with a volume of 1.8 ml.

The total of 113 full stomachs collected during the study contained: 121 fish (1064 ml, 72), 102 crayfish (206.2 ml, 61), 684 prawns (53.82 ml, 46), 69 insects (9.26 ml, 31), 16.52 ml of detritus from 23 stomachs, 28 amphipods (0.09 ml, 13), 8 snails (0.2 ml, 8), 7 unidentified vertebrates (6.77 ml, 7), 9 unidentified items (6.1 ml, 7), 5 snakes (402 ml, 5), 3 salamanders (2.8 ml, 3), 2 frogs (25.9 ml, 2), 2 fiddler crabs (0.9 ml, 2), 2 instances of bird remains (18 ml, 2), 2 mud sirens or eels (52.5 ml, 2) and cooked meat for a volume of 47.2 ml found in two stomachs.

Further identification of the fish taken from the stomach contents of the bowfin from Helena Run and Lake Harris showed the following groups of fish present: 15 centrarchids ranging 1-6 inches in length, 3 catfish from 2-8.5 inches long, and 7 cyprinodontids from 1-1.5 inches long.

In comparison, the stomach contents of bowfin from Lake Griffin contained 30 threadfin shad, 2-5 inches long, an 8½ inch gizzard shad, 3 cyprinodontids, each 1 inch long, one 3 inch catfish, and one 1½ inch centrarchid.

DISCUSSION

The bowfin has been generally reported to be a piscivorous fish, and the present study showed the diet to be 56 per cent fish (Table 1). However, Berry (1955) noted that out of 77 stomachs from Newnan's Lake, Florida, only two were found that did not contain fish. A similar situation was found only in Lake Dora (Table 1).

The occurrences of crayfish, frogs, insects, carrion, and snails are similar to the variety of food items found by Lagler and Hubbs (1940) and by Lagler and Applegate (1942) from southern Michigan waters. The rather high percentage of prawns and snakes may be peculiar to the diet of bowfin in central Florida (Table 1).

TABLE 1

Stomach contents of Bowfin (*Amia calva*)[1]

	Pisces	Serpentes	Astacidae	Palaemonetes	Insecta	Miscellaneous
Helena Run	24 (28)	1 (38)	28 (19)	13 (0.2)	28 (0.8)	6 (14)
Lake Griffin	11 (80)	—	5 (7)	76 (7)	—	8 (6)
Little Lake Harris	16 (21)	3 (51)	37 (15)	19 (0.3)	11 (0.5)	14 (12.2)
Lake Harris	22 (72)	2 (19)	22 (6)	18 (0.5)	20 (1)	16 (1.5)
Lake Dora	82 (98)	—	—	—	—	18 (2)
St. Johns River	18 (79)	6 (17)	18 (3)	41 (0.1)	—	17 (0.9)
All specimens	12 (56)	0.5 (20)	10 (10)	65 (4)	8 (0.5)	4.5 (9.5)

[1]Percentages are given by number (and in parentheses by volume).

Neither of these items was reported by Scott (1938), Lagler and Hubbs (1940), Lagler and Applegate (1942), or Berry (1955).

In 1955, Berry found that the bowfin provided no control on the shad population in Newnan's Lake. Scott (1938), on the basis of a food study in which he found that bowfin ate mostly game fish in Indiana lakes, reported that bowfin are destructive and useless. It is important to note that 88 per cent of the volume of fish found in the stomach contents of bowfin taken from Lake Griffin contained shad (Fig. 1). From a fish management standpoint, it appears that the bowfin in Lake Griffin may exert a considerable control on the shad population. The bowfin from Lake Griffin contained only about 1 per cent game fish by volume. Shad were not evident in the stomach contents from Lake Harris and Helena Run, and there was an increase in game fish and catfish consumption representing greater pressure on desirable species in these waters (Fig. 1).

Conclusion

From the great variety of food items contained in the bowfin stomachs, it seems that this species will eat whatever it can catch and swallow. The incidence of snakes in the stomach contents indicates a very aggressive nature, a character that makes the bowfin a desirable species for anglers.

Whether or not bowfin can be used as a management tool depends on the individual circumstances of the particular habitat in question. A bowfin population which is harmful in one lake might prove an effective control on rough fish in another lake.

The data show that during the months of January, February, and March the main food item of bowfin in central Florida is fish. Crayfish and prawns represent the second and third most valuable food items. Snakes are present in high volume, but have a low frequency of occurrence. Perhaps as more snakes become active with the warming weather their value in the bowfin diet will increase. The rather high frequency of insects in the diet may be contrasted to their low volume.

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